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Detached shear layers in a rotating spherical Couette flow of sodium with an imposed dipolar magnetic field

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The Derviche Tourneur Sodium (DTS) experiment has been designed to study instabilities and turbulence in the magnetostrophic regime, which governs the dynamics of planetary cores. In this regime, the Coriolis and Lorentz forces are expected to be in balance. Forty litres of liquid sodium fill a spherical shell between a 7cm-radius copper inner sphere and a 21-cm radius outer shell made of stainless steel. Both spheres can rotate around a vertical axis at different angular frequencies between -30 and 30 Hz. The inner sphere encloses a spherical permanent magnet providing a dipolar field with a moment of 700 Am^2.

In the rotating spherical Couette flow without a magnetic field, the basic flow consists of a detached shear layer parallel to the rotation axis: the Stewartson layer. With a dipolar magnetic field and without global rotation, another type of detached shear layer is predicted by linear theory: it follows the magnetic field line tangent to the outer sphere and exhibits azimuthal velocities larger than that of solid body rotation (Dormy et al, *J. Fluid Mech.* **452**, 263-291, 2002).

In the DTS experiment, we measure the azimuthal velocities beneath the thin external Hartmann layer by monitoring electric potentials at the surface of the outer sphere. Constraints on the meridional circulation are obtained from the induced magnetic field measured above the surface, and from radial profiles of radial velocity in the liquid sodium, using ultrasonic Doppler velocimetry. Super-rotation is observed in DTS but latitudinal profiles of azimuthal velocity display equatorial values higher than predicted by the linear theory. We think that this is due to the meridional circulation, whose amplitude reaches 5-10% of the azimuthal velocities. We will also present observations pertaining to the instabilities of the detached shear layers.